Table of flood stages March to June, inclusive, 1933—Continued

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Lower Mississippi Basin					
	Feet			*Feet*	
St. Francis:					
Chaonia, Mo	22	Apr. 16	Apr. 19	35.3	Apr. 17.
		May 3	May 3	24.7	May 3.
		May 12	May 18	38.0	May 15.
Fisk, Mo	20	Apr. 16	Apr. 22	26.5	Apr. 17–18.
		May 2	May 10	23.5	May 4.
		May 12	May 21	26.9	May 15–16.
St. Francis, Ark	18	Apr. 15	Apr. 28	25.0	Apr. 21.
		May 5	May 28	27.1	May 18.
Madison, Ark	32	Apr. 15	Apr. 15	32.3	Apr. 15.
Tallahatchie: Swan Lake, Miss	24	Dec. 16	June 9	33.4	Apr. 8.
Yazoo:					
Greenwood, Miss	36	Mar. 29	Apr. 27	38.2	Apr. 14–17.
Yazoo City, Miss	25	Feb. 8	June 18	31.2	May 6–7.
Ouachita: Arkadelphia, Ark	12	May 16	May 16	12.0	May 16.
Black: Jonesville, La	50	May 9	May 14	50.1	May 11–13.
Mississippi:					
New Madrid, Mo	34	Mar. 26	Apr. 30	40.8	Apr. 6.
		May 15	June 5	40.7	May 22–24.
Memphis, Tenn	35	Apr. 3	Apr. 20	39.0	Apr. 11.
		May 22	June 7	38.7	May 29.
Helena, Ark	41	Mar. 31	May 7	50.5	Apr. 13.
		May 19	June 12	50.6	June 2–3.
Arkansas City, Ark	42	Apr. 3	June 17	51.8	Apr. 17–19.
				53.6	June 4–6.
Greenville, Miss	36	Apr. 5	June 19	44.7	Apr. 18–20.
				47.2	June 6–7.
Vicksburg, Miss	45	Apr. 14	May 14	48.1	Apr. 22.
		May 27	June 18	48.8	June 10.
Natchez, Miss	46	Apr. 17	May 19	49.6	May 2–3.
		May 26	June 21	50.4	June 12.
Angola, La	45	Apr. 21	May 20	47.6	May 5.
		May 29	June 21	48.0	June 12–14.
Baton Rouge, La	35	Apr. 20	June 23	38.0	May 4–5.
				38.5	June 15.
Donaldsonville, La	28	Apr. 22	May 19	29.8	May 5.
		June 2	June 22	30.1	June 14.
Reserve, La	22	Apr. 25	May 17	23.0	May 5.
		June 6	June 20	23.1	June 14–16.
New Orleans, La	17	May 2	May 12	17.4	May 4.
		June 10	June 19	17.4	June 15–16.
Atchafalaya Basin					
Atchafalaya:					
Simmesport, La	41	May 6	May 14	41.2	May 9–12.
		June 12	June 14	41.0	June 12–14.

Table of flood stages March to June, inclusive, 1933—Continued

River and stotion	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
MISSISSIPPI SYSTEM—continued					
Atchafalaya Basin—Continued					
Atchafalaya—Continued	*Feet*			*Feet*	
Melville, La	37	Apr. 25	May 21	38.3	May 6–11.
		May 31	June 21	38.4	June 13–14.
Atchafalaya, La	22	Jan. 10	June 29	24.1	May 8–16.
					June 10–18.
WEST GULF OF MEXICO DRAINAGE					
Trinity:					
Dallas, Tex	28	Mar. 6	Mar. 8	34.0	Mar. 7.
		Apr. 26	Apr. 26	28.7	Apr. 26.
		May 16	May 17	32.0	May 16.
		May 26	May 28	32.2	May 26.
Trinidad, Tex	28	Mar. 10	Mar. 17	34.3	Mar. 14.
		Apr. 29	May 1	29.1	Apr. 30.
		May 29	June 7	32.3	June 4.
Liberty, Tex	25	Mar. 8	Mar. 13	26.0	Mar. 10–11.
GULF OF CALIFORNIA DRAINAGE					
Eagle: Eagle, Colo	5	June 1	June 2	5.5	June 2.
		June 4	June 8	6.0	June 7.
		June 10	June 18	6.8	June 12.
Roaring Fork: Carbondale, Colo	5	May 31	June 7	6.1	June 2.
		June 10	June 21	6.4	June 12.
North Fork: Paonia, Colo	9	May 31	May 31	9.2	May 31.
Gunnison: Delta, Colo	9	May 27	June 7	10.5	June 2.
		June 12	June 13	9.2	June 12.
Colorado:					
Grand Junction, Colo	11	June 3	June 3	11.5	June 3.
		June 13	June 13	11.0	June 13.
Parker, Ariz	7	May 26	June 30	11.4	June 19, 20, 22, 23.
PACIFIC SLOPE DRAINAGE					
Columbia Basin					
Kootanai: Bonners Ferry, Idaho	31	June 18	June 21	32.0	June 19.
Clark Fork: Newport, Wash	22	June 15	June 29	24.8	June 21–23.
Clearwater: Kamiah, Idaho	12	May 30	June 19	16.6	June 10.
Santiam: Jefferson, Oreg	10	June 9	June 9	12.0	June 9.
Willamette: Portland, Oreg	24	June 11	June 22	24.8	June 13.
Columbia:					
Marcus, Wash	24	May 14	[1]	38.7	June 22, 23.
The Dalles, Oreg	40	June 18	June 20	40.5	June 19.
Vancouver, Wash	15	May 28	[1]	25.5	June 19.

[1] Continued into July.

HISTORY OF THE APPLICATION OF METEOROLOGY TO AERONAUTICS WITH SPECIAL REFERENCE TO THE UNITED STATES [1]

By WILLIS RAY GREGG

INTRODUCTION

Aeronautics, as an industry, is less than 30 years old. Thus, it has come into being and developed to its present stature many years after the organization of national weather services. In this respect it is unique among the major industries.

Roughly speaking the world began to regard weather seriously about three quarters of a century ago. At that time agriculture, commerce, and marine navigation had been "going concerns" for centuries. True, in more recent years they have undergone marvelous development and change, but basically they were much the same then as now. It was necessary, therefore, that meteorological service be organized to meet the needs of these industries as they existed. With the changes in all lines of industry that have since occurred it has, of course been necessary for meteorological service to adapt itself to these changes. The same factor that has played a major role in revolutionizing industry, namely, the marvelous development in the speed of communications, is likewise largely responsible for the changes that have taken place in weather service. Speed in assembling the data and promptness in making them and the forecasts based on them available for use are the all-essential features in providing service to all classes of industry. Fortunately, when aeronautics appeared on the scene, demanding its share of service, the proper tools were at hand. It was only necessary to sharpen some of them, reshape others, and put them all to work.

MAN'S DESIRE TO FLY

Although aeronautics as an industry is not yet 30 years old, it is through no lack of desire on the part of man to fly that it was so late in arriving. From the earliest recorded times man has not only desired but in many cases has tried to fly. As early as the fourth century B.C., according to Aulus Gellius, a model was made of wood, in the form of a bird, and was to be flown by regulated mechanics. Thus, the first attempt of which we have a record was with a heavier-than-air device.

It is quite certain that an ascent was made in a hot-air balloon during the reign of the Emperor Nero, and perhaps the tragic ending of that flight marked the beginning of a much-too-long list of what we now call "aircraft accidents." That these were not merely isolated attempts of crack-brained enthusiasts is evident from a reading

[1] Read before the meeting of the American Meteorological Society, June 20, 1933, in connection with the Century of Progress Exposition, Chicago, Ill.

of one of the satires of Samostathenes, in which ridicule is heaped on those who had tried to devise various means for enabling men and ships to soar through the air, thus showing that the idea of flying already had many devotees. Occasional references to the subject are to be found also in the writings of Plautus, Juvenal, and many others of that period.

But, although there were many who worked on the problem, by far the greater number regarded the subject as one fit only for ridicule. Since man was not endowed with wings, it was not intended that he should fly, so they thought. And it was presumptuous for him to try to do so, and he should be punished for it! This view persisted for more than 20 centuries, and was prevalent down to a time within the memory of most of us. Witness the ridicule heaped on Langley—the only reward he received in his lifetime for all his splendid effort. As Wilbur Wright said in 1915: "By common consent men had adopted human flight as the standard of impossibility. When a man said: 'It can't be done—a man might as well try to fly', he was understood as expressing the final limit of impossibility."

Not but that man had been able to do *some* traveling in the upper air. In balloons he had done so innumerable times, but always subject to the vagaries of the winds. He had control only over his vertical movements. As to horizontal travel he was practically helpless. He could not go southward if a wind blew from that direction. Thus, 30 years ago, mankind generally was hopelessly skeptical as to the possibility of ever flying in heavier-than-air craft, and was firmly convinced that lighter-than-air navigation was merely a sport, having little to offer in the way of practical utility.

EARLY ASSOCIATION OF METEOROLOGY AND AERONAUTICS

Since aeronautics as an industry has developed wholly within the past few years, the application of meteorology to it would naturally seem to be limited to the same period. This is not strictly true, however, for the two have been more or less closely associated for nearly a century. Singularly enough the relationship was originally quite the opposite of that in recent years. Now, with some exceptions, it is meteorology that serves aeronautics. Formerly it was aeronautics that served meteorology. It was early seen that free balloons offered an opportunity for securing information not otherwise obtainable, and it is interesting to find that meteorological observations were made during balloon ascents by Dr. Jeffries, an American, as early as 1784 and by Benedict de Saussure in 1787. In the century that followed a large amount of data was collected in numerous ascents, among the most notable of which were the classic voyages of Glaisher, Flammarion, de Fonvielle, and Tissandier. Many of these reached great heights, including one in 1862 by Glaisher and Coxwell, which was estimated to have risen to 11,200 meters.

It is of particular interest to American meteorologists to find, in the "Report of the Chief Signal Officer for the Year 1872", the following paragraph:

> The experiment of a balloon ascension has been tried with fair results. The ascension was made by contract had with a professional aeronaut, and had in view the determination of the question whether the proper instruments could be carried and used with needful accuracy, an observer-sergeant being charged with the duty. One hundred and fifty-six readings were made during the ascension. This experiment is thought to have established that very delicate instruments may be employed hereafter, if it is considered advisable.

A very good prophecy to be abundantly fulfilled in later years.

THE METEOROLOGIST STUDIES THE UPPER AIR

Although the data accumulated in balloon ascents were extremely interesting, they yielded comparatively little of real value, owing to their fragmentary character and none too great accuracy. Moreover, this method was expensive and therefore fell in disfavor so far as its use in securing meteorological records is concerned.

The last quarter of the nineteenth century marks the beginning of really serious effort to secure systematic and accurate information concerning conditions in the upper air. It was during this period that several mountain observatories were established, including Pike's Peak, Colo., and Mount Washington, N.H., in this country. It was soon recognized, however, that, although the data were of great interest and value in certain studies, they were not truly representative of conditions in the free air. They were too much influenced by the mountain itself and by the neighboring terrain. In short, they represented neither true surface nor true free-air conditions.

It was during this period also that the study of clouds was begun in a scientific way. True, clouds had held a fascination for men since the dawn of history, and much had been written about them. Quite possibly one of these early observers, more keen than his fellows, noting the varying direction and speed of different layers of clouds, may have speculated as to the journey he would take, could he rise to their height and travel in the air currents that were speeding them along. In general, though, the literature of clouds prior to 1880 deals with their beauty, or associates their form and color with expected weather. There is little as to what they may reveal regarding the structure and characteristics of the atmosphere itself.

Following 1880, however, the systematic observation of clouds was taken up vigorously at the Blue Hill Observatory in this country; at Upsala, Sweden; and at Kew Observatory, England. The International Meteorological Committee considered the subject in 1885, largely through the interest of Hildebrandsson, and, at the meeting of the International Cloud Committee in 1894, besides the adoption of the nomenclature of clouds and instructions for observing them, it was decided to organize an international campaign of cloud observations. The plan was carried out from May 1, 1896, to May 1, 1897, in several European countries, at Toronto, Manila, and Batavia, and at Washington and Blue Hill in the United States. It is not too much to say that the data, which included the results of trigonometric observations, constituted a mine of information that yielded conclusions of far-reaching importance in our conception of the structure of the atmosphere.

Meanwhile other methods of upper-air study were being considered. In 1885 Prof. Cleveland Abbe, pioneer in many lines of meteorological research, urged the use of kites and, following the meeting of the International Conference on Aerial Navigation at Chicago in 1893, the project was rapidly developed. Notable series of records by this means were made in the United States by the Blue Hill Observatory under Rotch, Clayton, and Fergusson and by the Weather Bureau under Marvin, as well as in other countries, including particularly England, France, and Germany. In recent years kites have been largely abandoned in favor of the airplane which is more satisfactory in every respect. It is altogether likely that this method will be very extensively employed in the future.

The latter part of the nineteenth century saw also the advent of the sounding balloon. Both kites and airplanes have very decided limitations as to heights that they can reach. Only under exceptionally favorable conditions will kites go above 5 kilometers, and the average is much lower, about half this height. Airplanes have no difficulty in reaching 5 kilometers quite regularly, but going much above this is not practicable with existing types. Sounding balloons, on the other hand, have made possible the exploration of the upper atmosphere to heights of 20 to 30 kilometers. Their introduction marked an epoch of far-reaching importance in meteorology, since they led to the discovery of the stratosphere, the study of which, by Humphreys, Gold, and others, has led to a complete revision of our conception of the structure of the atmosphere. The first balloons were made of paper. Later, rubber balloons were employed and these are still in use at the present time. Among the names prominent in the pioneer stage of this type of investigation are those of Teisserenc de Bort, Richard Assmann, Hugo Hergesell, W. H. Dines, and A. Lawrence Rotch. The last named, as head of the Blue Hill Observatory, carried out several notable series of observations at St. Louis and over the tropical Atlantic.

In order to secure the greatest possible value from the observations there was organized an "International Commission for Scientific Aeronautics," later called "International Commission for the Exploration of the Upper Air", under whose general direction simultaneous ascents were made in many countries on designated "international days." For many years the data have been published in collected form and are thus available for synoptic as well as individual studies.

Data that are secured by means of kites, airplanes, and sounding balloons include pressure, temperature, and humidity. Observations of wind are also made with the kites and sounding balloons. Comparatively light instruments, called meteorographs, have been designed for recording these elements. Recently considerable work has been done in the development of radio-meteorographs, but these are still to a large extent in the experimental stage. It is of interest to note, however, that some good records have recently been secured at Fairbanks, Alaska. This method, if it is successfully developed and can be employed at reasonable cost, should prove a most valuable addition to those now in use, since by its use observations can be made in types of weather and in isolated regions in which all other methods fail.

One of these "other methods", and a most important one, is the use of so-called "pilot balloons." This method is comparatively inexpensive, but it yields information only regarding winds at various levels and the heights of clouds. Moreover, its use is limited to clear weather or to regions below clouds. Nevertheless, it has added greatly to our knowledge of the upper air. Its value will be vastly enhanced if it can be combined with radio, so that observations can be made in cloudy as well as in clear weather. Pilot balloons are undoubtedly used more extensively than any other method of free-air exploration. In the United States alone, including Alaska, Hawaii, and Puerto Rico, there are nearly 100 stations at which observations are made from two to four times each day.

Within the past 5 years, "ceiling" balloons have been added to the list of devices used in unraveling the secrets of the atmosphere. These are miniature pilot balloons—toy balloons in fact. They serve one purpose only, that of determining the height of clouds, or what is generally referred to as "ceiling." This use of the word is perhaps unfortunate, since ceiling also defines the maximum height which any given airplane can reach. However, both uses are now firmly established and in general there is little likelihood of confusion.

Ceiling balloons can be used efficiently only in determining the heights of relatively low clouds, chiefly those up to about 2,000 feet above the surface. They are of inestimable value in giving current information for fliers and are also providing an immense body of statistical data regarding the heights of lower clouds in different parts of the country, at different times of the day, in the various seasons of the year, and under varying conditions of pressure distribution. Similar data are obtained at night by means of ceiling lights.

It is an interesting fact that all of the earlier efforts to explore the upper air had as their chief aim not the application of meteorology to aeronautics but the increasing of our knowledge of the structure of the atmosphere. Some thought was given to the use of this added information in forecasting, but for the most part "aerology" was looked upon as "pure science" rather than as "applied science." It is quite natural that this should have been the case. Prior to the World War, aeronautics as an industry did not exist. There were stunt flights and trial flights with new designs. Due regard was of course paid to the weather prevailing at the time. But the pilot was his own observer. Forecasts rarely were requested except in the case of the National and International Free-Balloon Contests for which it was necessary to fix a definite date some time in advance. Many of the leading balloonists were themselves pretty fair meteorologists and in some cases a professional meteorologist was taken on the flight as aide and adviser. A beginning had been made also in Germany in connection with flights of the Zeppelin airships but, for the most part, there was little direct application of meteorology to aeronautics anywhere in the world.

Fortunately, however, the data that were being secured for purposes other than their usefulness to aeronautics were destined later to serve that activity in a very real and vital way. They provided a fund of information as to average conditions of air density and movement which were of great aid in connection with the design and construction of aircraft of all types. In a very real sense, therefore, meteorology may be said to have been ready for aeronautics when the latter called for its aid.

METEOROLOGY AND AERONAUTICS IN THE WORLD WAR

As the Great War provided the impetus for the rapid development of aeronautics itself, so naturally it heralded the advent of many assisting agencies. Meteorology, one of the chief of these, had much of value to offer in the way of statistical information, but it now became necessary to develop a more direct relationship—that of current service. Stumblingly at first, but more surely as experience pointed the way, each major power engaged in the war built up a service that was remarkably efficient, considering the short time in which it was done. The most important lesson learned was that aeronautics requires a much more intensive and detailed type of service than is needed for any other human activity. More observing stations and more frequent reports from those stations were necessary. Forecasts for 24 to 36 hours were of little value. They were therefore supplemented by forecasts for 1 or 2 to 5 or 6 hours, depending on the expected duration of any given operation. Naturally every possible effort was made by each side to prevent its reports and forecasts from reaching the enemy. This

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made all the more necessary the organization of a detailed and intensive service by each side in territory under its control.

The entry of the United States in the war marked the first official recognition by this country of the importance of meteorological service to aeronautics. In May 1917 Congress incorporated in the War Department bill an act entitled "For the establishment and maintenance by the Weather Bureau of additional aerological stations, for observing, measuring, and investigating atmospheric phenomena in the aid of aeronautics, including salaries, travel, and other expenses in the city of Washington and elsewhere, $100,000 to be expended under the direction of the Secretary of Agriculture." This appropriation was to be used in the United States proper and was therefore in addition to what was spent in meteorological service at the front. The latter was in general similar to that previously organized by other countries engaged in the war and was of course coordinated, so far as possible, with those of the countries with which the United States was associated.

The appropriation of $100,000 was used largely in establishing five additional aerological stations in this country, and in carrying out various projects in cooperation with the War and Navy Departments. Among these was a very thorough investigation of the use of pilot balloons, leading to the adoption of a formula for their rate of ascent for different weights, free lifts, etc. Many of the data, already accumulated by means of kites, sounding balloons, etc., were summarized and published for the information and use of the military branches of the Government. In every possible way meteorology endeavored to do its part in winning the war.

POST-WAR DAYS

Following the ending of hostilities there came a period of several years in which little progress was made. Aeronautics itself underwent a discouraging slump, particularly in this country. It was natural, therefore, that there should have been a slackening of effort in meteorological service. Fortunately, however, the special appropriation of $100,000 was continued each year, being transferred from the War Department direct to the Weather Bureau. The aerological program was therefore continued, even though no extension was possible. With the data thus secured several investigations were carried out, among the most important perhaps being that which led to the adoption of a "standard atmosphere." Other studies set forth the essential characteristics of the atmosphere and their relation to aeronautics.

That there was an increasing recognition and appreciation of the importance of weather service is evident in several ways. For example, early in 1919 the Navy Department staged the first successful crossing of the Atlantic by air. The preparations included an elaborate system of weather reports from the Atlantic, which were used as a basis for forecasts. Other trans-Atlantic attempts, long cross-country flights, and free-balloon contests all took full cognizance of the necessity for information concerning the weather.

An event of considerable significance was the inauguration by the Weather Bureau on December 1, 1918, of so-called "flying-weather forecasts", designed chiefly to assist the aerial operations of the War, Navy, and Post Office Departments. In the earlier years these forecasts were given for areas or zones. Later they were changed to cover specific routes or airways. This system was thus the forerunner of the present service of intensive, short-period route and trip forecasts.

Meanwhile the War and Navy departments had organized small meteorological units of their own, which, in cooperation with the Weather Bureau, provided special service for their particular needs. Observations obtained at the stations controlled by each of these organizations were made available to the others, both for current use and for statistical purposes, and thus duplication of effort and expense was avoided or at any rate kept to a minimum.

During this period of 6 or 7 years after the war, progress was rather more rapid in some of the European countries, where national subsidies made possible the laying out of civil airways and the establishment of meteorological service and other aids for scheduled flying. Generally speaking, though, there as here this whole period was one of transition and experiment. Aeronautics had demonstrated its utility in military operations. What had it to offer for peace-time pursuits? The public was skeptical. It had to be shown. A few stunt flights would not do this. What did? Undoubtedly, more than anything else in this country, the notable record made by the Air Mail was responsible for bringing aeronautics into its own. That record definitely showed that schedules can be set up and followed with a high percentage of regularity. When the public became aware of this fact, it was ready to take action accordingly.

METEOROLOGY AND CIVIL AERONAUTICS

That action found expression in the Air Commerce Act, passed by Congress on May 20, 1926. Before the passage of this act there was no Federal regulation of civil aeronautics in this country. Instead there was regulation of various sorts in different States with hopeless confusion resulting. The Air Commerce Act provided the proper authority for changing this. Machinery was set up for issuance of regulations, licensing of pilots, classifying of airports, and inspection of aircraft. For this work the Aeronautics Branch was organized, under an additional assistant secretary, in the Department of Commerce.

An equally important part of Federal encouragement and support of aeronautics is the provision of navigational and other aids, such as emergency landing fields, beacon lights, prompt communication facilities, and adequate weather service for all flying activities on Federally established civil airways. Except for the weather service, responsibility for providing these aids was placed in the Bureau of Lighthouses, of the Department of Commerce, a new branch known as the Airways Division being created for this purpose.

The work of organizing and maintaining an adequate weather service was naturally assigned to the Weather Bureau, whose already-existing elaborate system of reports and forecasts for general needs made necessary only an extension along similar lines, though in more detail, to meet the requirements of pilots. As authority for this service the Weather Bureau's organic act was amended to include specifically the furnishing of weather reports, forecasts, and warnings "to promote the safety and efficiency of air navigation in the United States and above the high seas, particularly upon civil airways designated by the Secretary of Commerce under authority of law as routes suitable for air commerce."

The present service for civil aeronautics in the United States, including Alaska and Hawaii, has been organized and is now functioning under the authority contained in this act. It is not necessary here to discuss in detail the essential features of this service. That has been done from time to time in other papers. Broadly speaking, the service is simply an extension of that already organized for general public activities. At different times in the past special needs have arisen, such, for example, as those for protection of fruit from frost, forests from fires, marine shipping from storms, certain areas from floods, etc. In each case the basic weather service already in existence was adapted and intensified to meet those special needs. So with aeronautics. The chief difference is that in this new activity the factor of danger to life and property is more acute than in ordinary pursuits. It has therefore been necessary to make the service more detailed and intensive. Observations are more numerous and forecasts are for shorter periods. Special attention is given to those conditions which are of chief importance, such as fog, low clouds, poor visibility, and thunderstorms.

Naturally the efficiency of the service depends in large measure on the speed with which the reports and forecasts are made available to pilots. The Department of Commerce, in cooperation with the Weather Bureau, has organized a system of communications which meets the need very effectively. About 13,000 miles of airways now have continuous teletype service. At important terminal airports on these airways and also on about 12,000 miles which do not yet have teletype service, radio stations have been established, partly for exchange of reports but chiefly for broadcasting information and forecasts to aircraft in flight. Thus, to the extent that is possible with appropriations made for the purpose, pilots are provided with up-to-the-minute reports and forecasts based thereon *before* each flight and with supplementary reports and forecasts at frequent intervals *during* each flight.

Only an extreme optimist would claim that the present service is the ideal. The service is only about 5 years old. During that period there has been much experimentation, with changes resulting as suggested by experience. There is reason to believe that the basic and essential features are sound and will probably endure, but there are bound to be changes in details as new ideas and methods are proposed. We should, and undoubtedly shall, in the future as in the past, adopt such changes as are shown to be superior to present methods in making aeronautics as safe and efficient as possible.

MOUNTAIN AND VALLEY ATMOSPHERIC-DUST MEASUREMENTS

By Irving F. Hand

[Weather Bureau, Washington, July 1933]

Although a fairly comprehensive series of atmospheric-dust measurements have been made from airplanes (see Monthly Weather Review for March 1924, vol. 52, pp. 133–139), but few comparative readings have been obtained from mountain tops and valleys below. Table 1 gives the results of five readings obtained on June 25 and 26, 1933, from the windward side of Skyland Drive at Crescent Rock, Va., on the Blue Ridge, at an altitude of 3,500 feet and from a point 2,600 feet below in the valley to the east 1 mile WSW of Syria at the foot of Dark Hollow.

While the number of observations is small, they tend to show the result of convection with increase of solar altitude. The number of particles in the valley seems rather high for free country air, but that may be owing in part to the large number of spores present. These measurements were made near dense forest growth. Moreover, while traffic was light on the road nearby, the infrequent cars that did pass raised considerable dust.

A slight rain fell shortly before the 1 p.m. reading of the 25th and again a little later the following day. On both days thunderstorms were seen in Page Valley west of the ridge toward evening.

The visibility was from 15 to 20 miles from Crescent Rock on both days. However, photographs on infrared films taken through a dense and very dark red filter show the Appalachian Range of mountains 30 to 40 miles to the west.

Perhaps the larger number of dust particles than might be ordinarily expected in free mountain air may account to some extent for the typical blueness for which the three ranges—the Blue Ridge, the Massanutten, and the Appalachian Mountains—are noted.

All measurements were made with the Owens dust counter, a description of which will be found in the issue of the Review above cited.

Table 1.—*Summary of atmospheric-dust measurements*

Date and time	Location	Height above sea level	Clouds	Wind	Number of dust particles per cubic centimeter
June 25:		*Feet*			
9:00 a.m.	Rose River	900	4 st. cu.	Lt. w.	729
10:00 a.m.	Crescent Rock	3,500	7 st. cu.	Lt. w.	277
1:00 p.m.	do.	3,500	9 st. cu.	Moderate w.	519
June 26:					
9:00 a.m.	do.[1]	3,500	Fog below; few fr. cu. above.	Calm	183
Noon	Rose River[2]	900	10 st.	Lt. var.	485

[1] Crescent Rock is about 1 mile from the tip of Hawk's Bill Mountain, the highest peak in the National Park of Virginia. From this point a commanding view toward the west is obtained.

[2] Rose River is a mountain stream. Near the place where the readings were obtained are a few scattered homes. The nearest town is Syria with a population of less than 100.